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(54) Computerized colour matching

(57) For matching a selected colour with predetermined available paint colours, a portable colour meter 10 is used to analyse a selected colour and store chromaticity data representing the hue, chroma and brightness of the selected colour. That stored chromaticity data is coupled to a computer 18 which compares it with stored chromaticity data 15 in the computer representing available colour formulas. The computer selects the stored paint formula most closely matching the chromaticity data representing the selected colour and generates signals to operate a colorant dispenser 26.

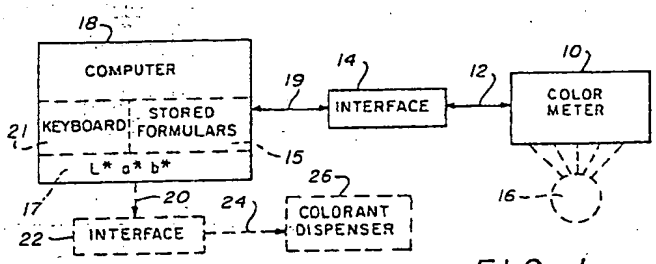

FIG. 1

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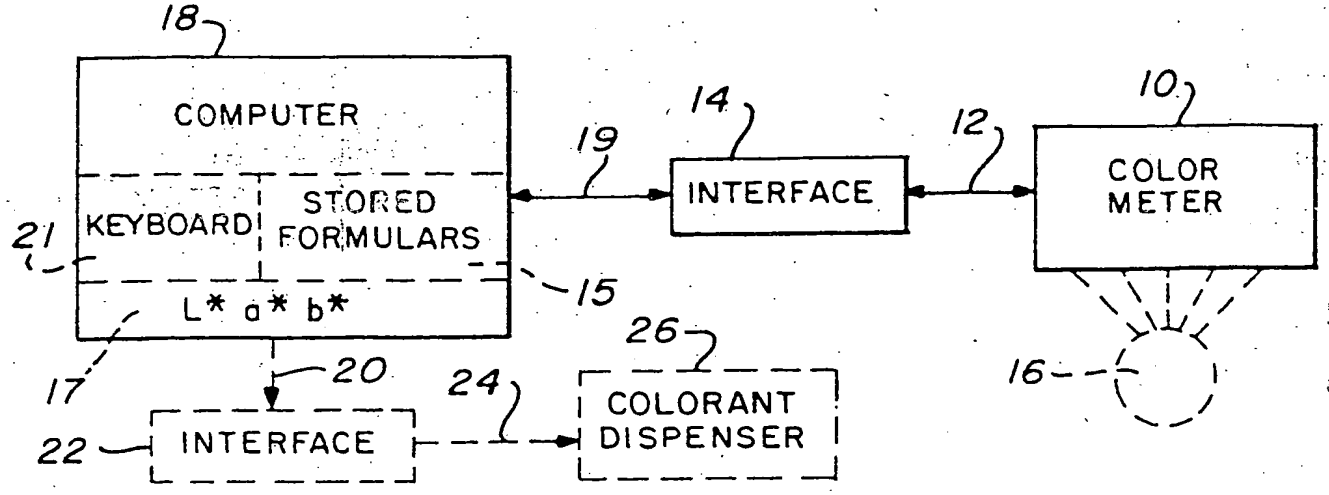

FIG. 1

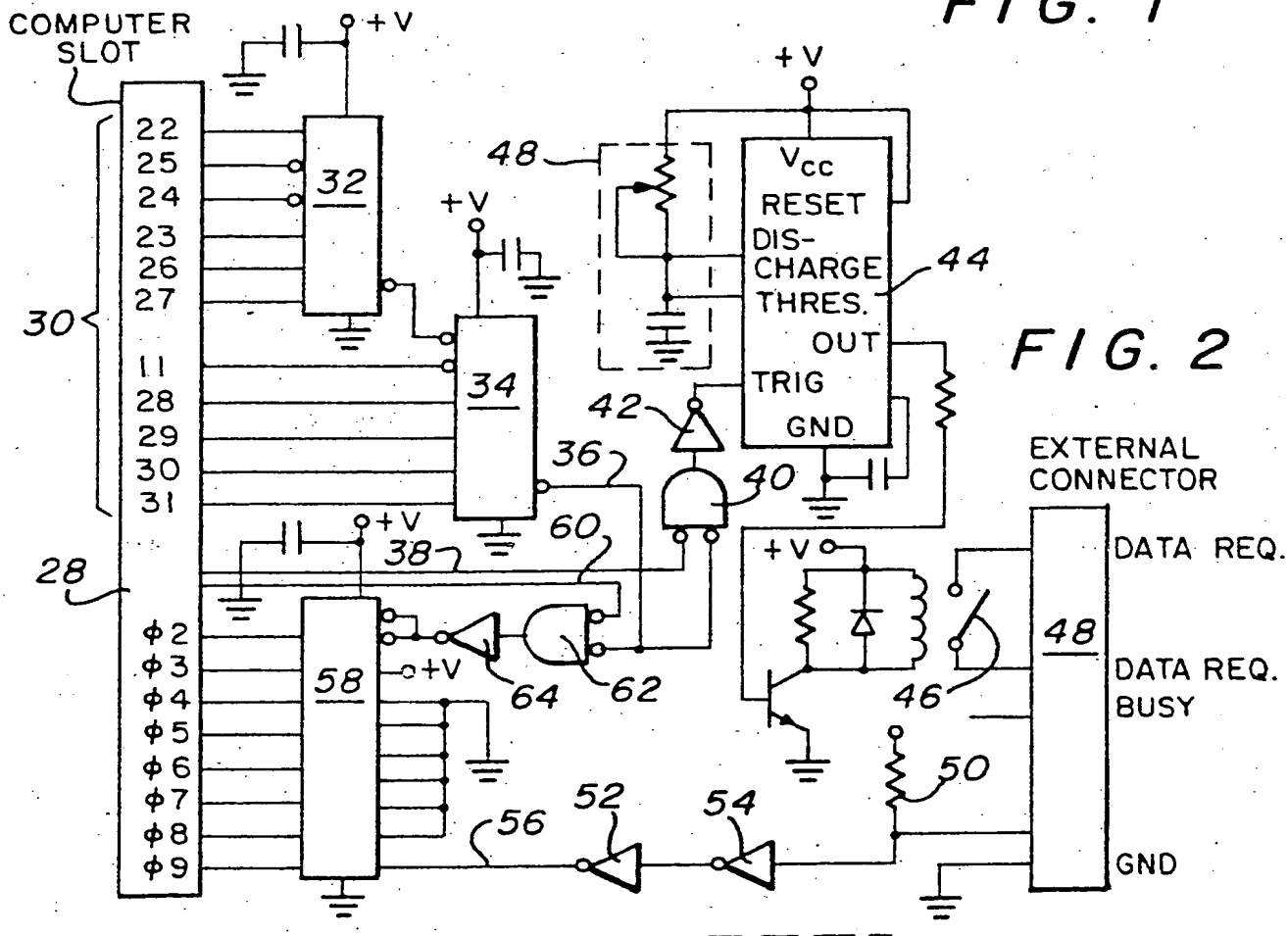

FIG. 2

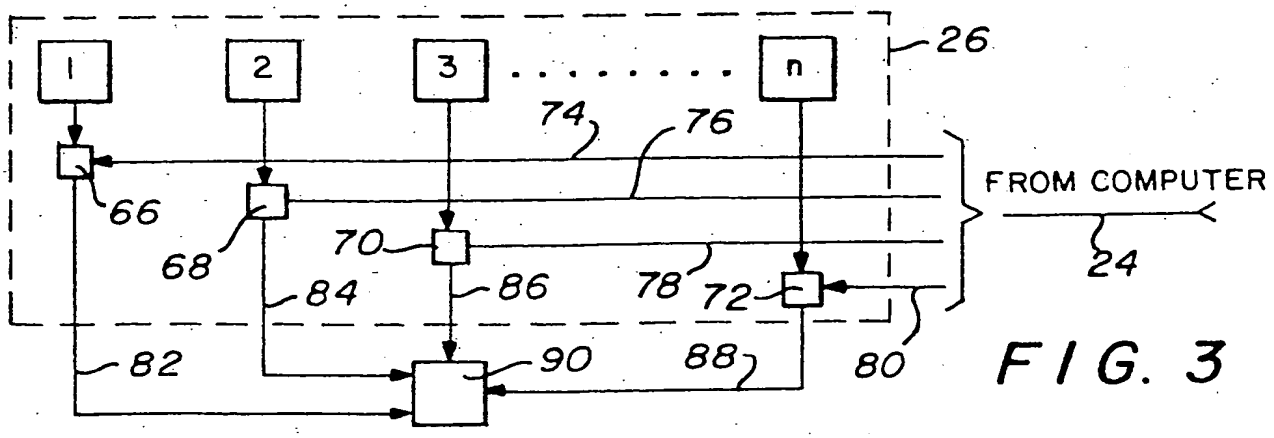

FIG. 3

SPECIFICATION

Computerized colour matching

The present invention relates to a method and apparatus for matching a selected colour with predetermined available paint pigments. In particular the invention relates to the use of a portable tri-stimulus colour meter which stores data representing an unknown colour and which may be hardwire interfaced directly with a computer to provide a simple to use yet extremely flexible system for providing a colour formula mostly closely matching the colour data of unknown colour at the touch of a computer key. The colour matching algorithms search a large data base of known and available colour formulas for the closest match with the unknown colour. "Available colour formula" means a verified colour formula that has actually been mixed as a paint. In addition, the use of a portable colour meter allows the meter to be disconnected from the system and taken into the field to obtain a colour reading at a remote location and then subsequently reconnected to the system whereupon the stored colour data may be directly read by the computer through the hard wire interface for colour matching. Alternatively, the data displayed by the colour meter may be communicated to the system in any well-known manner, as by telephone, from a remote location and entered into the computer through a keyboard.

Colour matching systems are well known in the art as set forth in US-A-3601589. In this patent, a computer assisted colour matching technique is disclosed which determines the total spectral reflectance of an unknown colour panel by a scanning spectrophotometer and then submits the reflectance data to a computer which generates a theoretical colour match by mathematical manipulation of previously stored data representing K and S values (absorption and scattering respectively) of pure pigments. The disclosure relates basically to a set of computational procedures which allow for the calculation of K (absorption) and S (scattering) values for a set of wavelengths and further determines a set of pure pigments such that the combined K and S values of the pigments equal the K and S values for the unknown colour at each wavelength of the set. This is the basic colour matching algorithm used by other spectrophotometric based colour matching systems.

The problems with these systems are that, first, they are extremely expensive and difficult to maintain and secondly, they generate a theoretical colour match utilizing data obtained for the unknown as well as the known pure pigments of the unknown colour. Thus the final colour which is obtained by mixing pigments according to the calculated colour values may turn out to be a colour different than the unknown colour. The colour match formula is normally a first mathematical approximation which must be corrected and adjusted by correcting software which is a part of the system.

The present system has several advantages over the prior art systems. First, the colour meter is a portable device well known in the art which may be taken into the field to obtain a colour reading at a remote location and store chromaticity data represented by three values such as the well-known L*a*b* measurement. The colour meter is subsequently transported back and reconnected to the computer system whereupon the stored colour data may be directly read by the computer through the hard wire interface for colour matching or the three values could be entered into the computer through a keyboard.

In addition, the computer searches a large data base of known and available colour formulas, each of which is represented by three values such as the well-known L*a*b* values, for the closest match, not necessarily an identical match. The three values providing the closest match point to or request an existing paint formulation stored in another area in the computer memory which can to be utilized to provide a paint that is a closest match to the unknown colour.

Thus, in the present apparatus and method, the colour meter may be transported to a remote location to obtain a colour reading of some particular unknown colour, transported back to the central location of the computer, such as at a paint store, and connected to the computer which then extracts the data from the colour meter, or alternatively, the three values representing the chromaticity data are keyed into the computer through the keyboard. In either case, the computer searches through a large database comprised of three values representing each available paint formula to find the closest match. Once the three values representing the closest match are found, they point to and select the corresponding paint formula from a group of stored paint formula in the computer memory. The selected formulas can be used to control the mixing of the pigments necessary to obtain the closest available colour match. This has not been heretofor possible in the prior art since, with existing systems, the unknown colour must first be brought to the central location of the computer where the computer generates an approximate colour formulation of the unknown colour which then may have to be corrected and adjusted to find the closest match.

Thus it is an object of the present invention to provide a colour matching system in which colour data representing an unknown colour is determined and then compared with a large database of available colour formulas to determine the closest match.

It is also an object of the present invention to provide a portable colour meter which can be taken to a remote location to obtain a colour reading and then the reading entered into the computer through a keyboard or the meter transported to the central location for hard wire coupling to a computer to analyse the stored data and determine the closest match available.

Thus the present invention relates to a method of matching a selected colour with predetermined available paint colours to obtain the closest match comprising the steps of using a portable colour meter to analyse the selected colour and store

chromaticity data representing the hue, chroma and brightness of the selected colour, coupling the selected chromaticity data in the portable colour analyser to a computer, comparing the selected colour chromaticity data representing the selected colour with stored data in the computer representing available paint formulas and selecting the one of the stored available paint formulas most closely matching the chromaticity data representing the selected colour.

The invention also relates to apparatus for matching a selected colour with predetermined available paint colours comprising a portable colour meter for analyzing the selected colour and storing chromaticity data representing the hue, chroma and brightness of the selected colour, a computer for storing a plurality of available paint formulas, means for coupling the stored chromaticity data in the portable colour meter to the computer, means in the computer for comparing the selected colour chromaticity data with the stored data representing available paint formaulas, and means for selecting the one of the stored available paint formulas most closely matching the chromaticity data representing the selected colour.

One example of both a method and apparatus according to the present invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a block diagram representing the novel paint colour matching system;

Figure 2 is a schematic drawing of the interface which couples a portable colour meter with the computer shown in Figure 1; and

Figure 3 is a schematic representation of a paint mixing system which may be controlled by the output from the computer to actually mix the paints to obtain the available colour most closely matched with the unknown colour.

In Figure 1, the colour meter 10 represents a portable, well-known colour meter such as the Minolta Chroma meter CR-100/CR-110 which is a portable light weight, compact tri-stimulus colour analyser for measuring reflected colour. Readings are taken through the measuring head, processed by a built in microcomputer and presented digitally on the custom designed liquid crystal display. Five measuring modes are selectable according to need. There are two chromaticity measuring modes and three colour deviation measuring modes.

For two colours to appear to match, three quantities defining these colours must be identical. These three quantities are called tri-stimulus values XYZ as determined by the CIE (Commission International De L'Eclairage) in 1931. Color as perceived has three dimensions; hue, chroma and brightness. Chromaticity includes hue and chroma (saturation), specified by the X and Y in a CIE chromaticity diagram well known in the art. Since this is a two dimensional diagram it cannot describe a specific colour completely and therefore a brightness factor must also be included to identify a sample precisely.

There are several well-known methods of determining the values necessary to identify a specific colour. With the present system, the colour meter chromaticity measuring mode utilized is the well known L*a*b* measuring mode. This mode is concerned with human sensitivity to colours and is the only mode used on the colour meter specified herein in the present system except for calibrating the instrument and then the well-known Yxy mode is used.

Thus in Figure 1 the well-known portable colour meter 10 may be transported to any desired location and a colour is reading obtained from an unknown colour 16. The reading stored in the colour meter 10 and displayed in the form of three chromaticity values representing hue, chroma and brightness and designated as the well-known L*a*b* values. When the colour meter 10 is transported back to the computer location, a hard wire cable 12 is coupled between the colour meter 10 and an interface board 14 which is in and a part of computer 18 and which allows the computer 18 to communicate through cables 12 and 19 with the colour meter 10. The three values displayed by and stored in the colour meter may also be entered into the computer through its keyboard 21. This allows the three value L*a*b* data to be called in by telephone or other means from a remote location and entered into the computer 18 through keyboard 21.

The computer 18 has stored therein a large database of available colour formulas 15 (fifteen thousand or more) of available paints. Each formula is also represented by three values stored in memory area 17 and which values are designated by the well-known L*a*b* values which, again, are hue, chroma, and brightness and representing each paint to be formed by the available paint formulas stored in memory area 15.

The computer 18 requests the data from the colour meter 10 to be transmitted to the computer 18, if the data is not entered through the keyboard, and the computer 18 then compares the three values representing the colour formula of the unknown colour 16 with each of the three values stored in the memory area 17 of the computer 18 representing a respective one of a plurality of paints to be formed with the use of the stored available paint formulas and selects the one of the three stored values in memory 17 representing the available paint formula in memory area 15 most closely matching the three values representing the colour of the object 16. Once the computer 18 has found the closest match of the three chromaticity values, it selects the available paint formula stored in area 15 corresponding to those three closest matched values. It then generates signals on line 20 which are coupled through an interface 22 and line 24 to a colourant dispenser 26 which mixes the proper paint colourants to obtain the closest colour paint which would match the unknown colour of the object 16. The computer 18 may be, for example, an IBM PC Computer.

The details of the interface in Figure 1 which is located between the colour meter and the computer involves a cable 12, and a board 14 which takes samples of the signal and allows the computer 18 to accept them on its database from lines 12 and 19. The board 14 actually forms a part of the computer and is

mounted internally in the computer in one of the computer input slots. As indicated earlier, this particular circuit is made to interface the IMB PC Computer by using one of the addresses set aside for prototype boards. The specific address that is decoded for this use is 308 hexadecimal. Thus, as can be seen in Figure 2, a ten bit IO address 30 is coupled through the appropriate pins of connector 28 to decoders 32 and 34 which decode the 10 bit IO address. The output of decoder 34 on line 36 is combined with the signal on IO write line 38 by NOR-negated input AND gate 40 and inverter 42 to trigger a timer 44 which controls a relay 46. Relay 46 is used to request data from the colour meter 10. Lines 4 and 5 of external connector 48, when connected by relay 46, trigger the colour meter. A resistor/capacitor time constant 48 is provided to adjust the ON time of the relay 46. Maximum ON time for the relay is around .47 seconds.

After lines 4 and 5 of connector 48 have been closed (data request) the colour meter will start sending its stored three value L*a*b* data through its data output line to pin 2 of connector 48. A 10K pull-up resistor 50 coupled to the five volt power supply present on the board provides TTL (transistor transistor logic) level signals. Data is then fed through the two inverters 52 and 54 for buffering and shaping. The output of the inverters on line 56 is coupled to an input of an octal buffer 58. The buffer 58 provides the interface to the PC data bus on terminal 28. The address decode signal on line 36 and the signal on IO READ line 60 are combined through NOR-negated input AND gate 62 and inverter 64 and connected to the buffer 58 to provide the WRITE signal to the PC data bus.

Thus the IBM PC Computer 18 can interrogate the colour meter 10 and receive data therefrom in order that it can be processed. Also, as stated previously, the three value L*a*b* data sets can be read on the colour meter display and entered into computer 18 through keyboard 21. In computer 18, as stated earlier, the chromaticity data represented by the three values L*a*b* measurement data and received from the colour meter 10 through the interface board 14 is compared with the stored data in the computer representing available paint formulas. As pointed out earlier, these three values are those which represent the well-known L*a*b* colour measurement. One of these sets of three values is stored in the computer for each available colour formula. Also stored are the available colour formulas (which may be 15,000 or more). The computer then compares the three value chromaticity data set from the colour meter 10 with all the stored three value chromaticity data sets to find the nearest match and then selects the one of the stored paint formulas represented by the nearest match which most closely matching the selected unknown colour. Once the computer 18 has selected the available colour stored paint formula most closely matching the selected unknown colour, it generates signals on line 20 through interface 22 and cable 24 to the colourant dispenser 26. See Figure 1.

The details of the colourant dispenser are shown in Figure 3 and are well-known in the art. Thus a signal appearing on lines 74, 76, 78 and 80 may be from the computer 18 or from a light pen which can read the available colour formula selected and visually displayed by the computer 18. The signal on lines 74, 76, 78 and 80 operate metering pumps 66, 68, 70 and 72 to allow predetermined quantities of paint from containers 1, 2, 3, through n to be mixed and result in a paint colour 90 which most closely matches the selected unknown paint colour.

Thus there has been disclosed a colour matching system which has the advantages of utilizing a portable colour meter which can be transported to some remote location and a colour reading obtained and then transported to a central location, such as a paint store, where a computer is located. The computer is then coupled to the colour meter which samples the data stored in the colour meter representing the unknown colour.

Further the data stored in the colour meter is also displayed visually by the colour meter and can be communicated from a remote location, as by telephone, to the computer location where the data can be entered into the computer through a keyboard.

The computer then compares the unknown colour data with a database representing available colour formulas to provide the closest match to the unknown colour and then can be used to operate a colourant dispensing system to provide a paint which most closely matches the unknown colour. This system is economical, simple to use, and provides a final paint which is as close to the unknown colour as can be matched from available colour formulas.

CLAIMS

1. A method of matching a selected colour with predetermined available paint colours comprising the steps of:

using a portable colour meter to analyse the selected colour and store chromaticity data representing the hue, chroma and brightness of the colour;

passing the chromaticity data in the portable colour meter to a computer;

storing a plurality of available colour formulas in the computer;

storing chromaticity data in the computer representing hue, chroma and brightness of each paint designated by each of the stored available colour formulas;

comparing the chromaticity data received from the portable colour meter with the stored chromaticity data representing each of the stored available colour formulas to find the closest match; and

selecting the stored colour formula represented by the chromaticity data found to be the closest match thereby matching the selected colour.

2. A method as in claim 1, further comprising the step of storing the chromaticity data in the colour meter and the computer in the form of three values designated as the L*a*b* colour measurement values.

3. A method as in claim 1, further comprising the

steps of:

locating the computer in a fixed location;

utilizing the colour meter at a location remote from the computer to analyse the detected colour and store the chromaticity data;

transporting the colour meter with the stored chromaticity data from the remote location to the computer at the fixed location; and,

coupling the colour meter to the computer for enabling the closest colour match to be obtained.

4. A method as in claim 1, further comprising the steps of:

locating the computer in a fixed location;

utilizing the colour meter at a location remote from the computer to analyse the selected colour and display the chromaticity data;

transporting the colour meter with the stored transmitting the displayed chromaticity data from the remote location to the computer at the fixed location; and,

entering the transmitted data into the computer for enabling the closest colour match to be obtained.

5. A method as in claim 3, further comprising the steps of:

providing a plurality of containers of liquid paint colours, and

utilizing the selected available paint formula to mix predetermined ones of the liquid paint colours to obtain a paint of the closest match to the selected colour.

6. A method as in claim 5, further comprising the steps of:

providing metering pumps on each of the paint containers to allow or prevent paint flow from the containers; and

operating the metering pumps in accordance with the selected one of the stored available paint formulas to provide a paint of closest match with the selected colour.

7. Apparatus for matching a selected colour with predetermined available paint colours, comprising:

a portable colour meter for analysing the selected colour and storing chromaticity data representing the hue, chroma and brightness of the selected colour;

a computer for storing a plurality of available paint formulas and storing chromaticity data representing the hue, chroma and brightness of each paint designated by the stored available paint formulas;

means for coupling the stored chromaticity data in the portable colour meter to the computer;

means in the computer for comparing the selected colour chromaticity data with the stored chromaticity data in the computer representing each paint designated by the stored available paint formulas to find the closest match; and

means for selecting the one of the stored available paint formulas represented by a the closest match chromaticity data thereby matching the selected colour.

8. Apparatus as in claim 7, further comprising means for storing the chromaticity data in the colour meter and the computer in the form of three values designated as the L*a*b* colour measurement values.

9. Apparatus as in claim 8, further comprising:

means on the portable colour meter for displaying the stored three value L*a*b* measurement data representing the selected colour;

means for transmitting the displayed data from the portable colour meter to the computer at a location remote from the portable colour meter; and

keyboard means for entering the three value L*a*b* measurement data into the computer for enabling the closest colour match to be obtained.

10. Apparatus as in claim 7, further comprising:

a plurality of containers of liquid paint colours; and,

means for mixing predetermined ones of the liquid paint colours in accordance with selected available paint formula to obtain a paint of the closest match of the selected colour.

11. Apparatus as in claim 10, further comprising:

metering pumps on each of the paint containers to allow or prevent flow from the container; and

means for operating the metering pumps in accordance with the one of the stored available paint formulas selected by the computer to provide a paint of closest match with the selected colour.

12. Apparatus as in claim 11, further comprising means coupling the computer to the metering pumps for controlling the pumps in accordance with the one paint formula representing the closest match to the selected colour.

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